ANNEX 8
BETWEEN
THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
AND
ASTROBOTIC TECHNOLOGY, INC
UNDER
SPACE ACT UMBRELLA AGREEMENT SAA8-1950316
FOR
OPTICAL PRECISION AUTONOMOUS LANDING (OPAL) SENSOR FLIGHT TESTS

ARTICLE 1. PURPOSE

This Annex shall be for the purpose of conducting flight testing of the Astrobotic Technology, Inc. Optical Precision Autonomous Landing (OPAL) sensor onboard a NASA research aircraft at Langley Research Center (LaRC). The goal is to successfully collect OPAL imagery of Moon-like terrain near China Lake, CA, or mutually agreed to alternative location, from various altitudes and aircraft attitudes to validate the instrument and its associated software.

The legal authority for this Annex, consistent with the Umbrella Agreement, is in accordance with the National Aeronautics and Space Act (51 U.S.C. § 20113(e)).

ARTICLE 2. RESPONSIBILITIES

A. NASA LaRC will use reasonable efforts to:

1. Supply the NASA research aircraft for this effort. The aircraft options for this flight project are the Beechcraft UC-12B aircraft (N528NA) or the Beechcraft B200 aircraft (N529NA). Effort includes, but is not limited to, NASA personnel, travel, design, fabrication, upload, download, airworthiness, transit, and flight tests.
2. Iterate with Astrobotic to develop and finalize a Flight Test Requirements Document (FTRD).
3. Iterate with Astrobotic on aircraft configuration requirements for the OPAL instrument.
4. Supply the optical window.
5. Supply NASA LaRC ground truth data system as alternative to Astrobotic's data system if requested by Astrobotic.
6. Supply up to two (2) research pilots for each flight.
7. Design and provide the mounting structure for the Astrobotic camera and Compute Element. Design shall allow for the camera orientation to be adjusted manually in flight between data runs.

8. Secure a deployed base of operations from which the aircraft will operate, as well as any necessary support infrastructure such as an aircraft hangar and aircraft refueling.
9. Provide the required tool control and safety training for a hazardous industrial area to Astrobotic research team members that require access to the NASA LaRC hangar.
10. Provide access to the NASA LaRC hangar (normal operational hours Mon-Fri from 0700-1530 EST) and to building 1244 and the Research Aircraft Integration Laboratory (RAIL) (normal operational hours Mon-Fri from 0600-1800 EST).
11. Provide aircraft egress training to those Astrobotic personnel who will be flying on the aircraft.
12. Perform those airworthiness and operational safety processes necessary for the conduct of this mission in accordance with NASA Procedural Requirement (NPR) 7900.3, Aircraft Operations Management, Langley Procedural Requirement (LPR) 1710.18, Airworthiness Review Process, and Langley Management System Center Procedure 0960 (LMS-CP-0960), Conducting Flight Experiments Utilizing Research Services Directorate (RSD) Aircraft.
13. Conduct, with support from Astrobotic, integration and de-integration of Astrobotic components in the aircraft.
14. Develop, jointly with Astrobotic, a flight plan for flight tracks, altitude bands and pitch angle bands that allow for the OPAL sensor to image the terrain.
15. Develop, jointly with Astrobotic, a call and response protocol for allowing the Astrobotic researchers to move about the passenger cabin.
16. Share NASA supplementary meteorological information to support campaign team flight planning.
17. Supply real-time text and occasional voice communications between the aircraft and ground team. It is anticipated that the Iridium network can be used for both text and voice. Note that voice is typically less reliable than texts. Voice is only anticipated in the event of trouble shooting or another extremis situation.
18. Conduct flight testing (up to 10 research flight test hours).
19. Attend daily meetings with Astrobotic during flight testing to discuss matters such as technical issues, current and future weather conditions, down days required, and Go/No-Go decisions.
20. If required, remove/reinstall camera and/or Compute Element between flights.
21. Download and deliver flight test data if collected by NASA data system.

B. Partner will use reasonable efforts to:

1. Provide reimbursement, as outlined in the Financial Obligations Article, in advance of the initiation of NASA LaRC efforts.
2. Iterate with NASA LaRC to finalize FTRD.
3. Iterate with NASA LaRC on aircraft configuration requirements for the OPAL instrument.
4. Provide all components to the OPAL instrument, to include camera, lens, Compute Element, and all associated cabling/connectors.
5. Provide ground truth data system (if not using NASA LaRC system).

6. Provide instrument parameters in a NASA-provided Payload Information Form (PIF).
7. Provide all drawings, material certifications, and engineering analyses.
8. Ensure Astrobotic research team members that require access to the NASA LaRC hangar attend the tool control and safety training for a hazardous industrial area which is provided by the Research Systems Integration Branch (RSIB) within the NASA LaRC RSD. Note: Inability to comply with the tool control program or not adhering to safety protocol will result in that researcher being temporarily removed from the Hangar until training is remediated. Non-compliant toolboxes will be sequestered off the hangar floor.
9. Supply up to two (2) Astrobotic Qualified Non-Crewmembers to fly on the test aircraft and ensure the Astrobotic QNCs comply with the applicable NASA medical standards for QNCs.
10. Develop, jointly with NASA LaRC, a flight plan for flight tracks, altitude bands and pitch angle bands that allow for the OPAL sensor to image the terrain.
11. Develop, jointly with NASA LaRC, a call and response protocol for allowing the Astrobotic researchers to move about the passenger cabin.
12. Support NASA LaRC with integration and de-integration of Astrobotic components in the aircraft.
13. Obtain all meteorological support required during the flight project.
14. Attend daily meetings during flight testing to discuss matters such as technical issues, current and future weather conditions, down days required, and Go/No-Go decisions.
15. Lock the camera into position during aircraft take-off and landing.
16. Perform in-flight adjustments of the camera as needed to achieve desired angle "theta" between the camera x-axis and ground orthogonal.

ARTICLE 3. SCHEDULE AND MILESTONES

The planned major milestones for the activities for this Annex defined in the "Responsibilities" Article are as follows:

1. Astrobotic to provide required advance reimbursement, completed PIF, and all drawings, material certifications, and engineering analyses.	Within one (1) week following Effective Date of Annex.
2. NASA LaRC and Astrobotic to finalize FTRD.	Within one (1) week following Milestone 1
3. NASA LaRC to conduct SRR, Final Engineering Review, ER-ARB Final Airworthiness Review, and ORR.	Within one (1) week following Milestone 2
4. Astrobotic to deliver OPAL instrument and all related components.	Within one (1) week following Milestone 2

5. NASA LaRC and Astrobotic to integrate OPAL into aircraft.	Within one (1) week following Milestone 4
6. NASA LaRC to conduct OPAL instrument flight check.	Within one (1) week following Milestone 5
7. NASA LaRC to transit aircraft to deployed location.	Within one (1) week following Milestone 6
8. NASA LaRC to conduct flight tests with support from onboard Astrobotic QNCs.	Within one (1) week following Milestone 7 (Tentative Research Window is March 7-14, 2022)
9. NASA LaRC to download and deliver flight test data if collected by NASA data system.	Within one (1) week following Milestone 8
10. NASA LaRC and Astrobotic to complete de-integration of OPAL from aircraft.	Within one (1) week following Milestone 9

ARTICLE 4. FINANCIAL OBLIGATIONS

A. Partner agrees to reimburse NASA an estimated cost of $152,066 for NASA to carry out its responsibilities under this Annex. Each payment shall be marked with [NASA Langley Research Center (NASA LaRC) and SAA8-1930516-Annex 8, PAM-36078].

B. NASA will not provide services or incur costs beyond the current funding. Although NASA has made a good faith effort to accurately estimate its costs, it is understood that NASA provides no assurance that the proposed effort under this Annex will be accomplished for the estimated amount. Should the effort cost more than the estimate, Partner will be advised by NASA as soon as possible. Partner shall pay all costs incurred and have the option of canceling the remaining effort or providing additional funding to continue the proposed effort under the revised estimate. Should this Annex be terminated, or the effort completed at a cost less than the agreed-to estimated cost, NASA shall account for any unspent funds within [insert timeframe, cannot exceed one year] after completion of all effort under this Annex, and promptly thereafter, at Partner's option return any unspent funds to Partner or apply any such unspent funds to other activities under the Umbrella Agreement. Return of unspent funds will be processed via Electronic Funds Transfer (EFT) in accordance with 31 C.F.R. Part 208 and, upon request by NASA, Partner agrees to complete the Automated Clearing House (ACH) Vendor/Miscellaneous Payment Enrollment Form (SF 3881).

ARTICLE 5. INTELLECTUAL PROPERTY RIGHTS - DATA RIGHTS

A. Data produced under this Annex which is subject to paragraph C. of the Intellectual Property Rights - Data Rights Article of the Umbrella Agreement will be protected for the period of one (1) year.

B. Under paragraph H. of the Intellectual Property Rights - Data Rights Article of the Umbrella Agreement, Disclosing Party provides the following Data to Receiving Party. The lists below may not be comprehensive, are subject to change, and do not supersede any restrictive notice on the Data provided.

1. Background Data: *The Disclosing Party's Background Data, if any, will be identified in a separate technical document.*
2. Third Party Proprietary Data: *The Disclosing Party's Third Party Proprietary Data, if any, will be identified in a separate technical document.*
3. Controlled Government Data: *The Disclosing Party's Controlled Government Data, if any, will be identified in a separate technical document.*
4. The following software and related Data will be provided to Partner under a separate Software Usage Agreement: *None*

ARTICLE 6. TERM OF ANNEX

This Annex becomes effective upon the date of the last signature below ("Effective Date") and shall remain in effect until the completion of all obligations of both Parties hereto, or three (3) months from the Effective Date, whichever comes first, unless such term exceeds the duration of the Umbrella Agreement. The term of this Annex shall not exceed the term of the Umbrella Agreement. The Annex automatically expires upon the expiration of the Umbrella Agreement.

ARTICLE 7. RIGHT TO TERMINATE

Either Party may unilaterally terminate this Annex by providing thirty (30) calendar days written notice to the other Party.

ARTICLE 8. POINTS OF CONTACT

The following personnel are designated as the Points of Contact between the Parties in the performance of this Annex.

Management Points of Contact	
NASA Langley Research Center David F. Moore Associate Director Space Technology and Advanced Development Programs Mail Stop 104 Hampton, VA 23681 Phone: 757.864.9169 david.f.moore@nasa.gov	Astrobotic Technology, Inc. Jesse Kuhn Technical Project Manager 1016 N Lincoln Ave Pittsburgh, PA 15233 Phone: 570.847.8714 jesse.kuhn@astrobotic.com
Technical Points of Contact	

NASA Langley Research Center Glenn R. Jamison Research Pilot Mail Stop 256 Hampton, VA 23681 Office: 757.864.1776 Mobile: 757.403.8403 glenn.r.jamison@nasa.gov	Astrobotic Technology, Inc. Holly Lindenfelser Systems Engineer 1016 N Lincoln Ave Pittsburgh, PA 15233 Phone: 412.443.1947 holly.lindenfelser@astrobotic.com

ARTICLE 9. MODIFICATIONS

Any modification to this Annex shall be executed, in writing, and signed by an authorized representative of NASA and the Partner. Modification of an Annex does not modify the terms of the Umbrella Agreement.

ARTICLE 10. SIGNATORY AUTHORITY

The signatories to this Annex covenant and warrant that they have authority to execute this Annex. By signing below, the undersigned agrees to the above terms and conditions.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER

BY: DAVID DRESS Digitally signed by DAVID DRESS Date: 2022.02.01 12:32:48 -05'00'
David A. Dress
Director, Space Technology and Exploration Directorate

DATE:

ASTROBOTIC TECHNOLOGY, INC

BY:
John Thornton
CEO

DATE: 1/31/2022